crustaceans were corrected for the total area swept by the two trawls using the formula described by Krebs (1972).

Fish tissue samples for contaminant analyses were obtained from trawls. Targeted species included spot (*Leiostomus xanthurus*) and Atlantic croaker (*Micropogonias undulatus*). Silver perch (*Bairdiella chrysoura*) or weakfish (*Cynoscion regalis*) were collected if they were present when the target species were not. All fish samples were wrapped in foil and stored on ice in plastic bags until they could be frozen in the laboratory. Entire fish were then rinsed and homogenized in a stainless steel blender. Extraction and analytical procedures were similar to those described for sediments.

2.4. Habitat Evaluation

Observations were made at each site prior to departure to document the presence of litter (within the limits of the trawled area) and to note the proximity of the site to urban/suburban development or industrial development.

2.5. Quality Assurance

SCECAP protocols include rigorous quality assurance and quality control guidelines for all aspects of the program to ensure that the database is of high quality. A copy of the Quality Assurance Project Plan is maintained at the SCDNR Marine Resources Research Institute and has been approved by the USEPA NCA Program.

2.6. Data Analyses

Comparisons of most water quality, sediment quality and biological measures were completed using standard parametric tests or non-parametric tests where the values could not be transformed to meet parametric test assumptions. Two stations (RO046286 and RT042266) were not included in the comparisons, since these sites represented special study sites selected to add stations in the Charleston Harbor estuary. Comparisons of measurements collected in tidal creek versus open water habitats were conducted using a t-test or non-parametric Mann-Whitney U test. Comparisons involving more than two station groups or multiple years were generally completed using ANOVA or Kruskal-Wallis tests. Data from 2003 and 2004 were generally pooled within each habitat type to calculate the current condition of and temporal trends in most individuals measures. Data from the two years were separated within each habitat type to examine changes in integrated water quality and sediment quality scores, benthic biological condition and overall habitat quality as well as for several individual measures of particular concern.

Use of the probability-based sampling design provided an opportunity to statistically estimate, with confidence limits, the proportion of South Carolina's overall creek and open water habitat that falls within ranges of values that were selected based either on (1) state water quality criteria, (2) historical measurements collected by SCDHEC from 1993-1997 in the state's larger open water bodies (SCDHEC, 1998a), or (3) other thresholds indicative of stress based on sediment chemistry or biological condition (Hyland *et al*., 1999; Van Dolah *et al.,* 1999). These estimates were obtained through analysis of the cumulative distribution function (CDF) using procedures described by Diaz-Ramos *et al*. (1996).

3. RESULTS AND DISCUSSION

Data obtained from the 2003-2004 survey are summarized in the following sections. More extensive data summaries are also available on the SCECAP web site (http://www.dnr.sc.gov/marine/scecap/) and are referenced in this report as "data online."

3.1. Station Array

The locations of the 60 sites sampled in 2003 and 2004 are provided in Figures 3.1.1 - 3.1.4 and Appendix 1. Tidal creek station numbers are designated by RT, and open water stations are designated by RO. As noted previously, the two supplemental sites sampled in 2004 to obtain additional data for the Charleston Harbor estuary (RO046286 and RT042266) are not included in the general analyses of state-wide condition, but the data are available online.

The average depth of open water sites sampled during the two-year period was 5.2 m and varied from approximately 1.2-14.0 m (Appendix 1, data online).

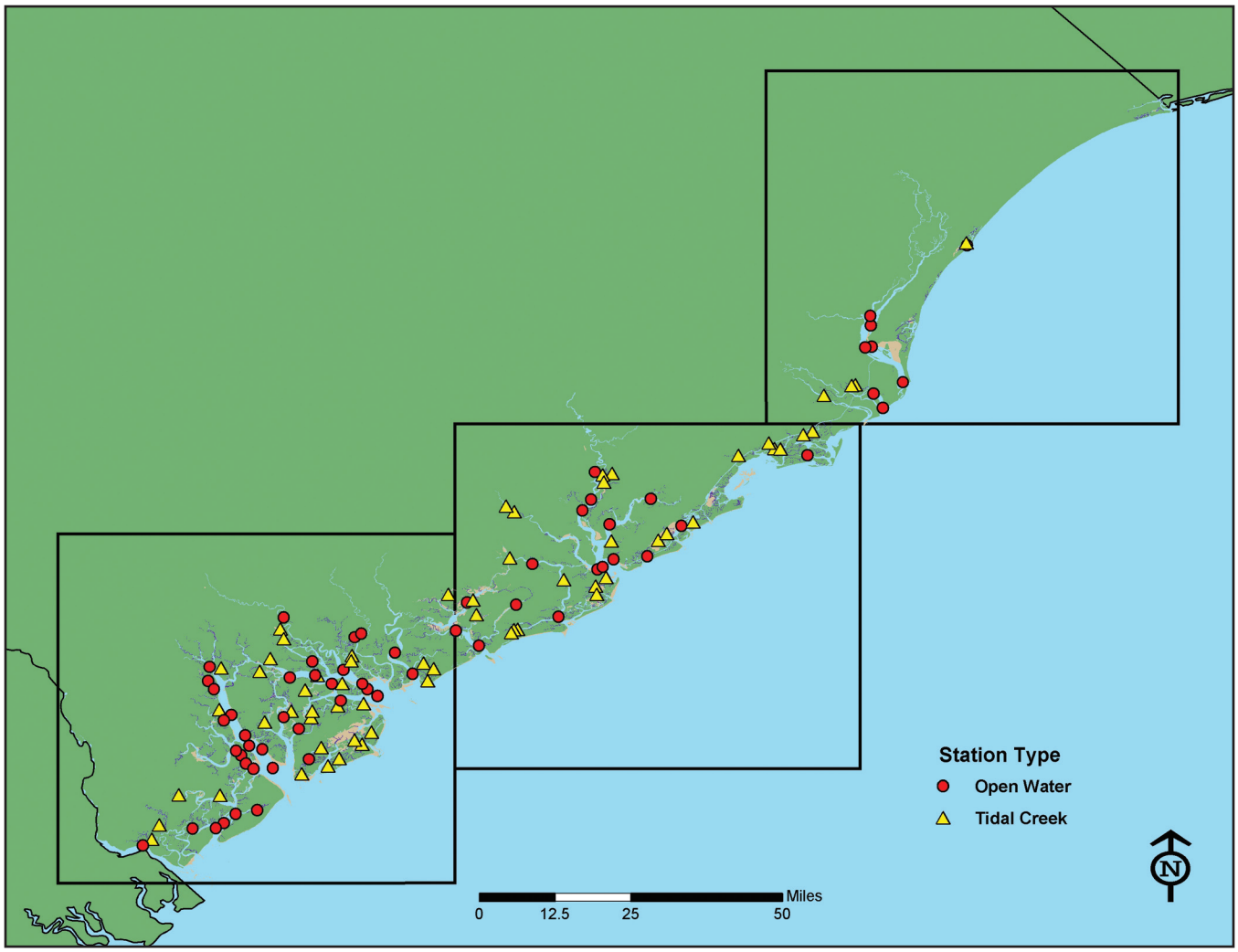

Figure 3.1.1. Distribution of open water and tidal creek stations sampled throughout South Carolina's coastal zone during 2003 - 2004 with northern, central and southern geographic regions outlined.

Average depth of the tidal creek sites was 2.5 m and varied from approximately 0.3 to 6.1 m. Only one site was substantially less than the 1 m minimum criteria due to unusual tidal conditions. Average depths and ranges were comparable to the previous survey periods (Van Dolah *et al*., 2002a, 2004a).

3.2. Water Quality

Although instantaneous measures of basic water quality variables (temperature, salinity, dissolved oxygen, pH) were obtained during the primary visit to each site, the continuous measures of these parameters from the 25-hr instrument deployments provide the most comprehensive information because they include numerous measures during both day and night over two complete tidal cycles. Therefore, these data are used as the primary data set in our analyses of these four water quality parameters. The other measures of water quality (total and dissolved nutrients, BOD_5, TSS, turbidity, TOC, total alkalinity, chlorophyll-*a*, and fecal coliform bacteria) obtained at each site represent instantaneous measures collected during the primary site visit.

State regulations 61-68 and 61-69 have been developed to protect the water quality of the state (SCDHEC, 2004). The water quality standards include numeric and narrative criteria that are used for setting permit limits on discharges to waters of the state, with

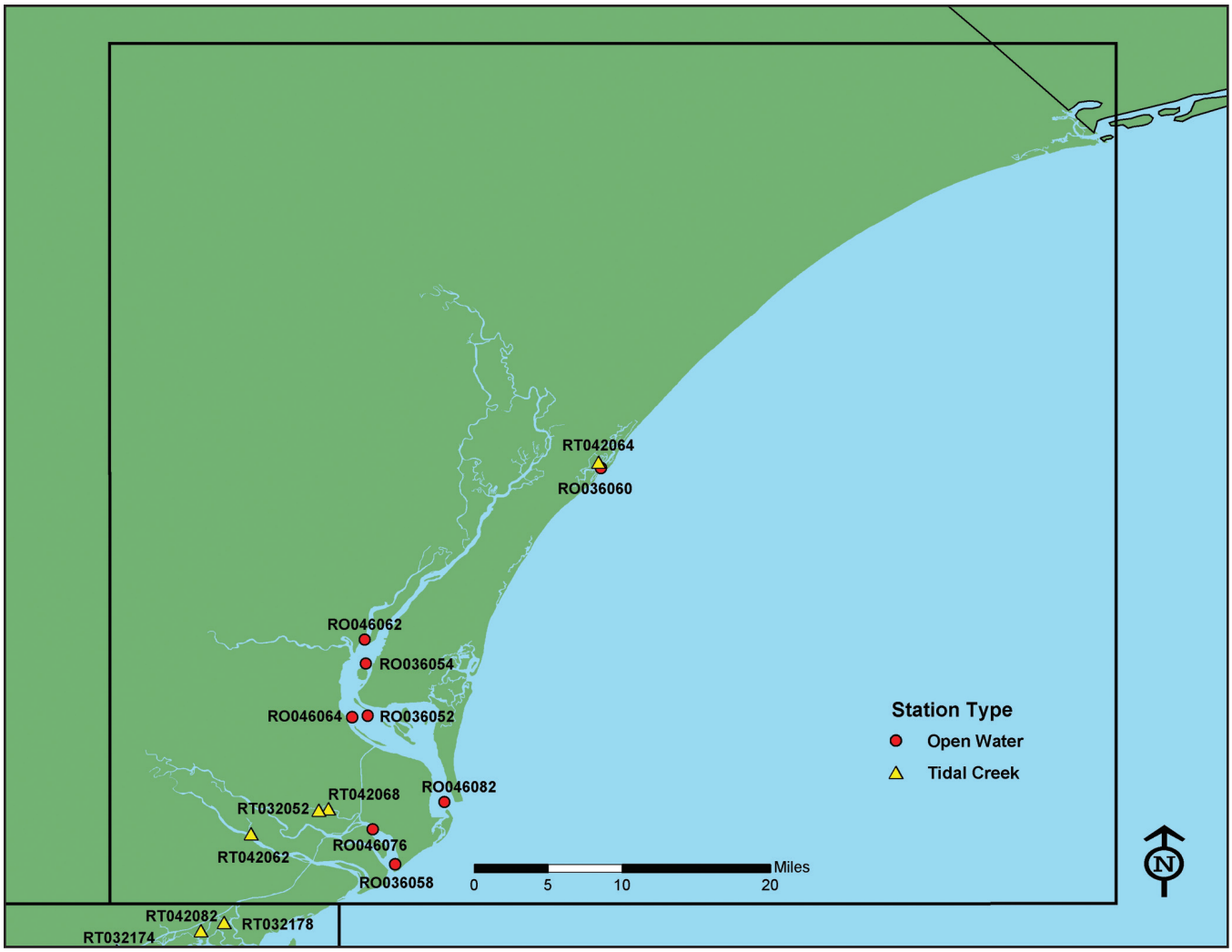

Figure 3.1.2. Distribution of open water and tidal creek stations sampled in the northern portion of the state during 2003 - 2004.

the intent of maintaining and improving surface waters "to a level to provide for the survival and propagation of a balanced indigenous aquatic community of flora and fauna and to provide for recreation in and on the water." Occasional short-term departures from these conditions will not automatically result in adverse effects to the biological community. The standards also recognize that deviations from these criteria may occur solely due to natural conditions and that the aquatic community is adapted to such conditions. In such circumstances, the variations do not represent standards violations, and critical conditions of the natural situation, e.g., low flow, high temperature, minimum dissolved oxygen, etc., are used as the basis of permit limits.

All data collected by SCECAP from field observations and water samples are related to water quality standards for the state's saltwater regions (SCDHEC, 2004) where possible. Because SCECAP samples are limited to a summer index period and generally do not include multiple samples over time, the summertime-only data are not appropriate for use in USEPA 303(d) or 305(b) reporting requirements. Additionally, only four water quality parameters have state water quality standards (dissolved oxygen, pH, turbidity, fecal coliform bacteria). For other parameters measured by SCECAP, values are compared to data compiled for a five-year period (1993-1997) by the SCDHEC Bureau of Water in their routine statewide Fixed Ambient Surface Water Monitoring Network

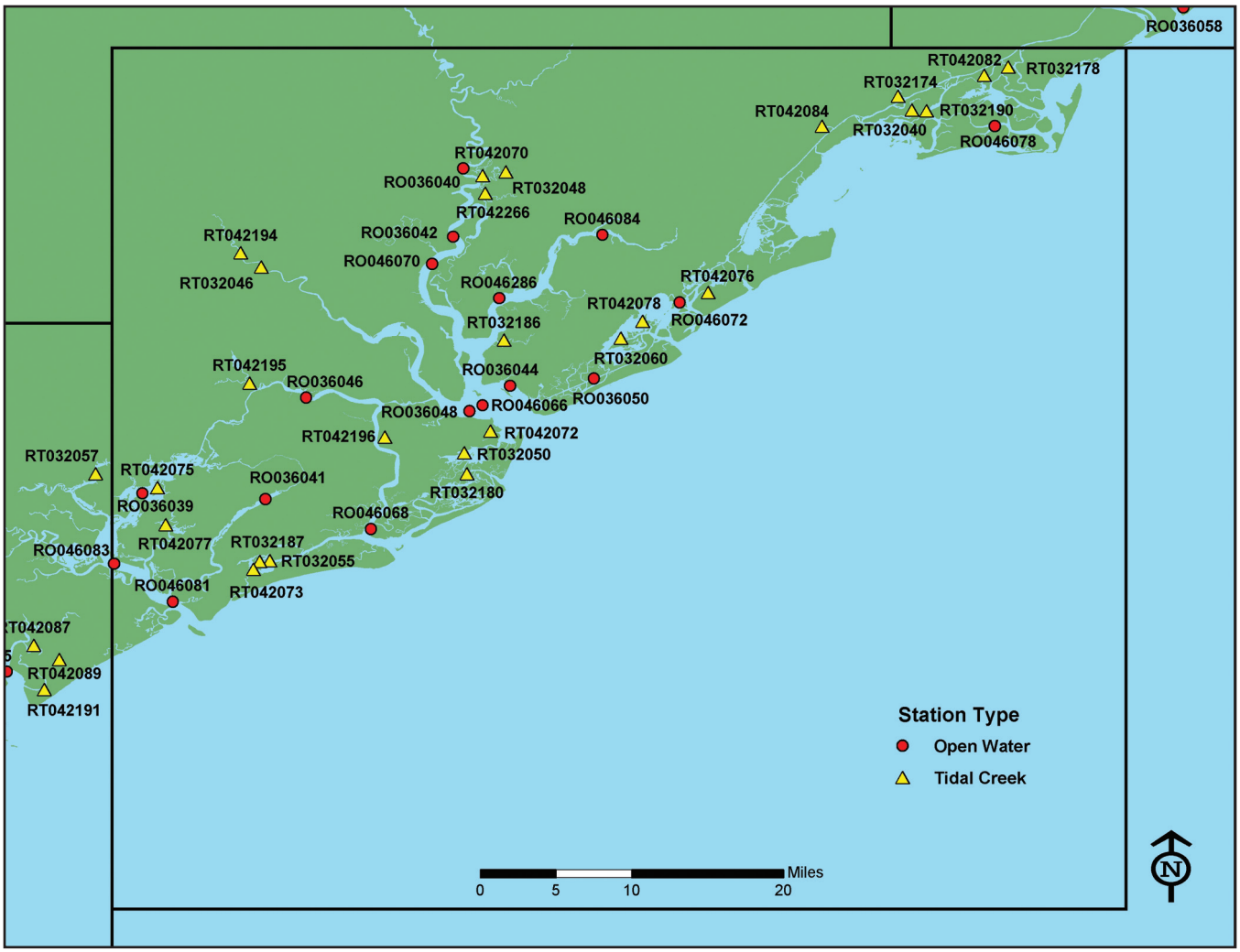

Figure 3.1.3. Distribution of open water and tidal creek stations sampled in the central portion of the state during 2003 – 2004.

(SCDHEC, 1998a). SCECAP criteria consider any value less than the 75th percentile of all 1993-1997 historical values measured (≥ method detection limit) in the state's saltwater habitats as evidence of normal (good) condition. Values exceeding the 75th percentile of the historical data are considered to be elevated (fair), and values exceeding the 90th percentile of all saltwater measures indicate high (poor) concentrations. The SCDHEC historical database on water quality was primarily obtained from larger open water bodies. Therefore, caution should be used in interpreting data obtained from tidal creek sites since high or low values observed for some parameters may represent "normal" conditions. Box 3.2.1 compares the 1993-1997 historical data to both the open water and tidal creek data collected from 1999-2004 by SCECAP. For some water quality variables, such as dissolved nutrients and chlorophyll-*a*, criteria or guidelines published in other reports are used for comparison of conditions (e.g. Bricker *et al*., 1999; USEPA, 2004) since no appropriate historical data were available for South Carolina.

SCECAP collects many water quality variables that are either required for the NCA Program or for SCDHEC's assessment of state water quality condition for USEPA 303(d) or 305(b) reporting purposes. This technical report summarizes salinity and all water quality parameters that are used for the integrated measure of overall water quality. This report does not summarize temperature, TOC, BOD_5, dissolved nutrients, and alkalinity. Temperature data are primarily collected to relate with other water

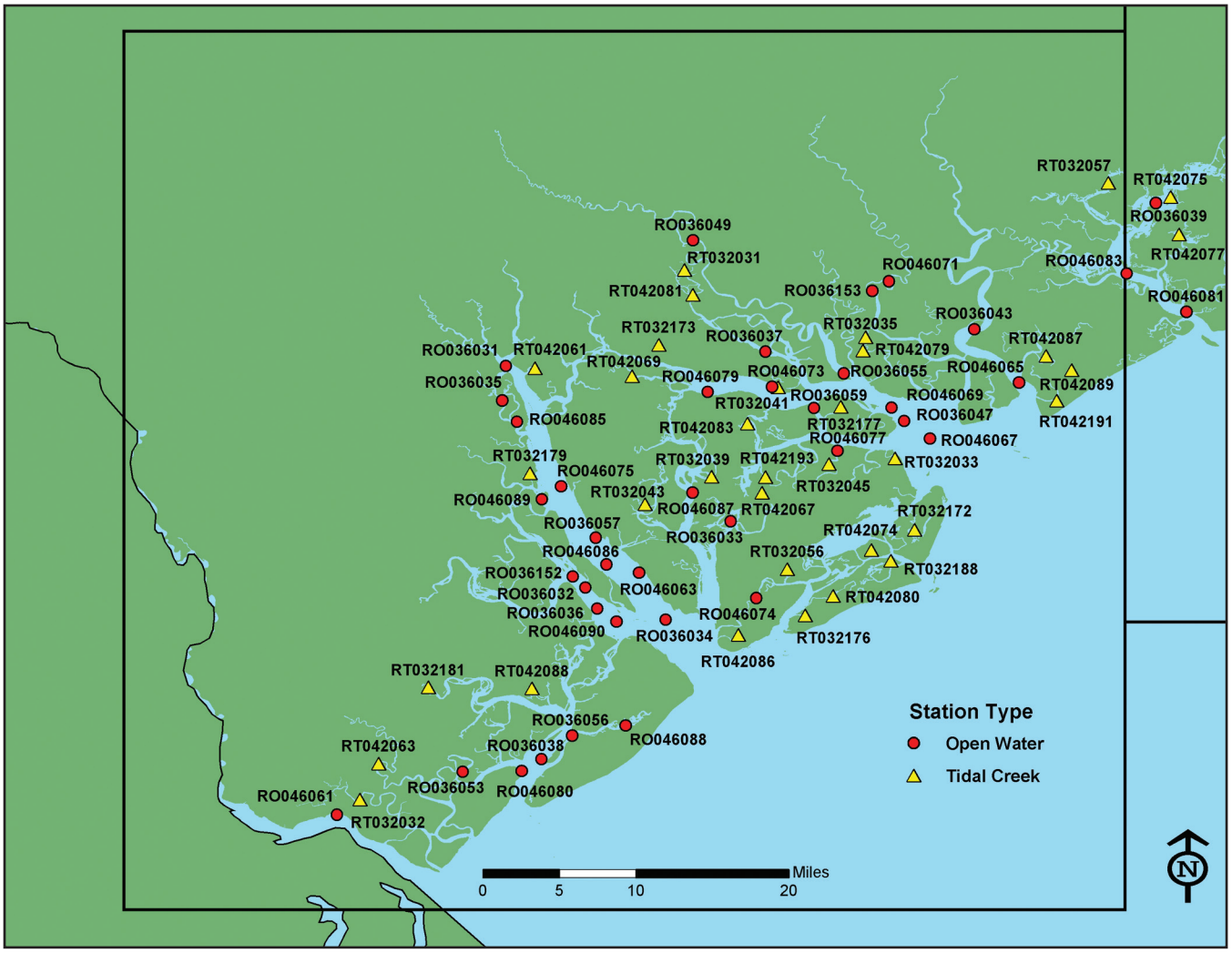

Figure 3.1.4. Distribution of open water and tidal creek stations sampled in the southern portion of the state during 2003 – 2004.

quality variables affected by this parameter. The other excluded parameters have no state standards for estuarine waters. Data on all parameters, reported or not, are provided on the SCECAP web site for those interested in acquiring the data.

Salinity

Salinity influences the distribution and diversity of many invertebrate and fish species and can be stressful to many organisms when large variations occur over short time periods. Mean bottom salinities of all sites sampled during the 2003-2004 survey were 23.5 ppt and 24.2 ppt in the tidal creek and open water habitats, respectively. This difference was not statistically significant ($p = 0.998$), but both means were lower than those observed in the previous two surveys conducted in 1999-2000 and 2001-2002. Additionally, the percentage of the state's estuarine waters that were considered to be oligohaline ($\leq$ 5 ppt) or mesohaline (> 5 to < 18 ppt) was 28% and 29% for tidal creeks and open water habitat, respectively, compared to < 11% for either habitat in the previous two surveys (Figure 3.2.1). This reflects the effects of increased rainfall following a four year record drought. While greater rainfall might be expected to increase the mean range of salinities observed at the sites sampled over a 25-hr period, this was not observed. The average salinity ranges observed were 4.2 ppt among the tidal creek sites and 6.8 ppt among the open water sites, which were similar to the average ranges observed in previous survey periods (data online). However, three tidal creek sites (RT032178,